The CRUSHED STONE JOURNAL

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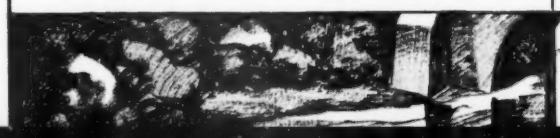
Official Publication

NATIONAL CRUSHED STONE ASSOCIATION



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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

NATIONAL CRUSHED STONE ASSOCIATION

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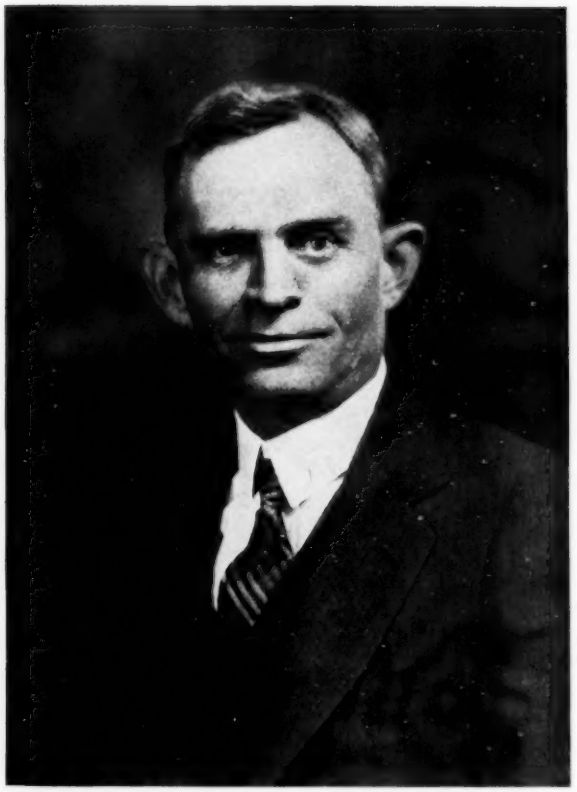

H. E. Rodes
President
Franklin Limestone Company, Nashville, Tennessee

who was elected President of the National Crushed Stone Association at its Nineteenth Annual Convention held in St. Louis, Missouri, January 27-30, 1936.

THE
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The Use of Large Size Aggregate in Concrete[1]

By T. C. POWERS
Assistant to the Director of Research,
Portland Cement Association, Chicago

◆ The use of large aggregate in mass concrete has outstanding advantages which Mr. Powers has clearly stated. Stone aggregate may always be produced in large sizes and consequently stone offers extraordinary possibilities in the production of economical mass concrete. Every stone producer should read this article.

TWENTY-SEVEN years ago, in 1909, concrete operations were under way on the Gatun Lock, Panama Canal, when the secondary crushers which reduced the trap rock from 8 to 3 inches were found temporarily out of commission. The division engineer, Colonel William L. Sibert, evidently in an experimental mood, ordered the work to proceed with a barge load of the 8-inch crusher-run material, and instructed Edward O. Keator, who was in charge, to observe the result. Mr. Keator reported in the Engineering Record[2] as follows:

"Unloading at the dock was done by a locomotive crane with a 3 cubic yard Brownhoist clam shell bucket. Some difficulty was experienced with the 8-inch material because the jaws would not readily penetrate the mass of large rock, but there was no delay on that account. No trouble at all was experienced in charging and mixing.

"The spill-way channel floor is 285 feet wide by 900 feet long of varying thickness. Placing at the time was going on at the extreme end where the thickness was but 18 inches on solid rock. At first there was some trouble because the men were not as careful as they should have been about placing the bucket in exactly the right spot before dumping. It was harder work to shovel the larger material than the smaller, but there was no difference in puddling. They soon learned where to dump the bucket to best advantage and there was no further difficulty. Since a single bucket contained 2 cubic yards, the necessity for placing the bucket in exactly the right spot may be readily seen. This concrete, in fact practically all the concrete in the spill-way, was the ideal, smooth, mushy mixture, easy to puddle and push into place. The writer had buckets of concrete made of the 8-inch aggregate dumped and flattened out to a thickness of 10 inches without any trouble, just to see if it could be done, and reported that the 8-inch material could just as well be used as the 3-inch."

This is the earliest reference found by the writer to the use of large aggregate put through the mixer.

Mr. Keator's experience evidently impressed him very favorably for in 1915, in the article from which the above quotation was taken, he tells of using 3 to 5-inch maximum size in building construction, flat slabs and columns, in 1913 at Portsmouth, Ohio, and 8-inch maximum in spillway repairs at San Antonio in 1914. He states also that 6-inch crusher-run was in use on the arches of the Florida East Coast Railway in 1914. Mr. Keator went so far as to advocate 6-inch stone or 7-inch gravel for 8-inch pavement.

After 1915 and up until the start of the Boulder Dam there were about 5½ million cubic yards of large aggregate concrete used in 20 mass structures in the west alone. Virtually all massive structures are now made with such large aggregate. The Chute-a-Caron and Boulder projects required over 4 million cubic yards of large aggregate concrete, and the Grand Coulee project will take 11 million more. The object of this discussion is to review some of

[1] Presented at the Nineteenth Annual Convention of the National Crushed Stone Association, St. Louis, Mo., January 27-30, 1936.
[2] Engineering Record, 71, 556, 1915.

the advantages that have led to such extensive use of this type of concrete. For convenience, concrete containing aggregate larger than about 2 inches will be referred to as mass concrete, whether the large particles are crushed stone or gravel.

The Nature of Mass Concrete

Attention is called to Figure 1, two cross-sections of hardened concrete. Except for differences in texture and photography, these two sections look very much alike. In each is seen a number of large particles spaced throughout a field in which there are smaller particles. The smaller particles are similarly separated and the still smaller ones likewise. The interesting thing about this illustration is that the section at the left is a photograph of a sample of the concrete used in the Bull Run Dam, the largest particle represented measuring 7 inches. The section on the right, however, represents ordinary concrete, the largest particle measuring 1½ inches. Before drawing inferences from the obvious similarities in these photographs it is instructive to scrutinize the ordinary concrete more closely. In Figure 2 there is shown on the left the same picture that appears at the right in Figure 1. The other half of this illustration is an enlargement of the marked-off area in the left-hand picture. The largest particles shown here measure about ½ to ¾ inch. In Figure 3 there is a further enlargement of part of the marked-off field shown in the preceding figure. Here the largest particle is only ¼ inch. And finally, in the fourth illustration, the mass concrete is compared directly with the magnified mortar.

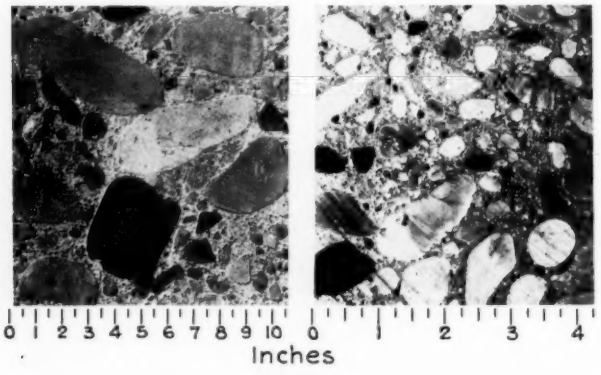


Figure 1
Comparison of Concrete Containing Large Aggregate with Ordinary Concrete

It is thus evident that in this series of progressively greater enlargement, the same fundamental structure was revealed. Mass concrete is fundamentally like ordinary concrete, or like the mortar which it contains. Just as for ordinary concrete, or for mortar, the major properties of mass concrete depend upon the quality of the hardened paste which envelopes and separates from one another the individual aggregate particles. The difference between mass and ordinary concretes, which makes mass concrete preferred for some structures, is only a matter of the degree to which certain properties are manifested. As will be seen later, it is largely a matter of difference in unit weight and of economy of materials.

Not only does mass concrete resemble ordinary concrete in the hardened state, but also in the plastic condition there is remarkably little difference. Those who witness for the first time the placing of mass concrete are invariably astounded at the ease with which it is handled and the inconspicuousness of the large rocks. When mixes are properly designed the concrete is plastic regardless of the size of the aggregate. (See Figures 5 and 6.)

At first, engineers saw in large aggregate only a means of getting better concrete. At a time when it was not uncommon to use 1-3-6 or even leaner mixes with small aggregate, better durability and watertightness were generally needed. This is not always the case at present, for it is now understood how to design for durability and watertightness with aggregate of almost any size. Furthermore, mixes can be designed so as to emphasize a particular property or set of properties most useful to the

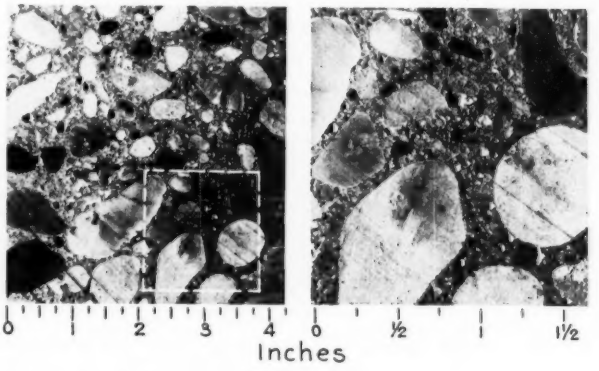


Figure 2
A Closer View of Ordinary Concrete. The picture at the right is an enlargement of the marked area indicated on the left. The left hand picture is the same as that which appears at the right in Figure 1.

structure. For mass concrete this usually means low temperature rise, high unit weight and watertightness. To this end the use of large aggregate is singularly well adapted, as will develop in the following discussion.

Designing for Special Use

Modern mix design for mass construction or any other purpose is based on very simple principles. Since the hardened paste envelopes the aggregate, stresses, weathering, and percolating water must first overcome the resistance offered by the paste. Also, the heat that causes temperature rise is generated in the paste and the volume changes that accompany changes in moisture content are confined largely to the paste. Furthermore, with ordinary mineral aggregates, the paste is the lightest of the materials in the concrete. Therefore, selection of the paste is the first step in design. With this established the course followed next depends on the kind of concrete required.

The requirements for mass concrete have already been mentioned. To produce the greatest possible unit weight, the lowest temperature rise and a minimum of drying shrinkage (or expansion on wetting) the paste content of the finished concrete must be kept as low as possible. However, the paste content cannot be arbitrarily reduced. There must always be a sufficient quantity to give the degree of workability required for the conditions and method of placement. For any given range of particle sizes there are numerous gradations which require the same minimum amount of paste for a given degree of workability; but once one of these proportions has been found, further reduction in paste content can be made only by the introduction of particles of larger maximum size. The importance of this fact is illustrated in the Figure 7 which compares the amounts of concrete per bag of cement that can be made with aggregates differing as to maximum size. Note that the water-cement ratio is constant. This same information is conveyed in different terms in the next diagram, Figure 8. Here the quantity of cement required is shown as a function of the maximum size of the aggregate. On this diagram there is shown also the weight per cubic foot of the different concretes represented. It is thus apparent that, from the standpoint of the properties of the concrete, there is a very marked advantage in using the larger aggregate sizes for mass concrete construction.

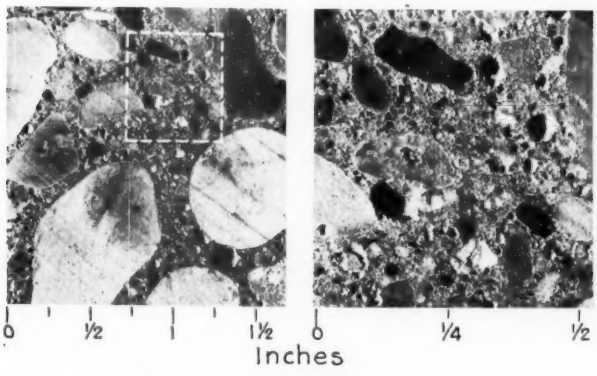


Figure 3

A Further Magnification of Ordinary Concrete. The picture at the right is an enlargement of the marked area shown at the left. The picture at the left is the same as that which appears at the right in Figure 2.

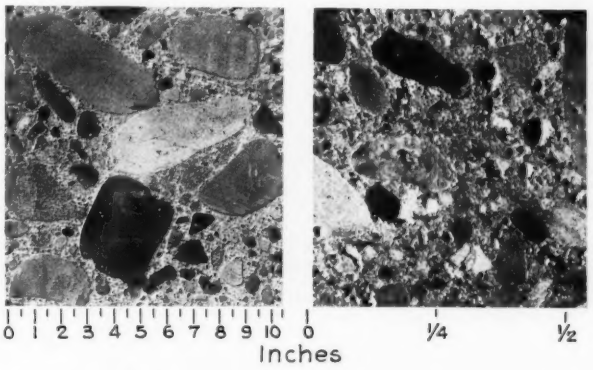


Figure 4

A Direct Comparison of Large Aggregate Concrete with a Magnified Mortar. This is the left hand picture of Figure 1 compared with the right hand picture of Figure 3.

Besides the points considered above, there is also the extremely important matter of economy. This arises from two sources: A lower cement requirement, and cheaper aggregate. The economy in cement is especially marked for increases in maximum size up to 3 or 4 inches. It is obvious that, because of the saving in cement, a maximum size of at least 3 or 4 inches should be used when the dimensions of the structure will permit and where the material is at all available. On the other hand, it can be seen that to obtain sizes larger than 4 inches might or might not be economical, depending upon circumstances. If the large aggregate is at hand, the chart shows that the cost of concrete would be reduced not only by the cost of the cement which could be omitted, but also by the cost of crushing or wast-

ing the larger sizes. If it were necessary to import at extra expense the larger particles, however, the cost of the extra material would have to be balanced against the cost of the relatively small amount of cement that could be saved.

There is to be considered also the saving in the required concrete yardage in a gravity section which may be made possible by the greater unit weight, assuming, of course, that the design is based on actual weight, rather than some figure taken from a text book. The plant set-up required to handle the larger aggregate is more costly than the usual plant, but for yardages of the usual magnitude this is an insignificant item compared with the possibilities of economy in materials.

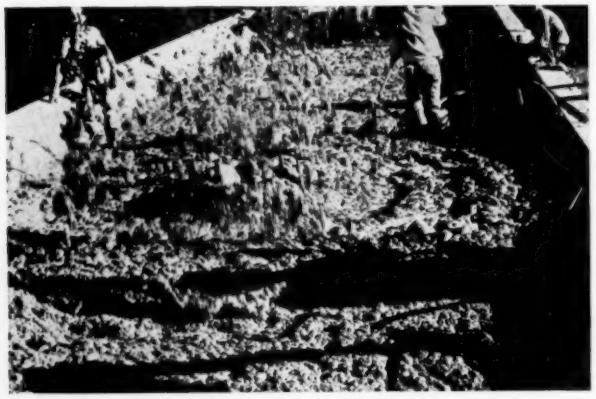


Figure 5
Placing Mass Concrete at Boulder Dam. The bucket has just dropped its load and has been jerked upward out of view by the recoil of the cableway. The concentric waves reveal the plastic nature of the mix. Note the large cobble in the center, just dropping into the mass.

Effect of the Large Aggregate

In the above discussion it has been tacitly assumed that so far as strength, watertightness, and weathering are concerned, all of such concretes as represented in Figures 7 and 8, for example, are equally suitable. This is a proposition not easily accepted by many engineers who are very naturally reluctant to believe that concrete containing, say, 4 sacks of cement per cubic yard could be as good as concrete containing 5 sacks or more, as implied in Figures 7 and 8. Nevertheless, when regarded from the viewpoint of the water-cement ratio law, it is seen that the cement content is not necessarily the factor controlling the quality and that it is easily possible for concrete differing widely in cement content to be very similar. But it is not necessary to rely on the theory in this respect. During the past ten years there has been a large amount of research[1] on this subject, the most noteworthy being that carried out by the Bureau of Reclamation in their Denver laboratories. Those tests show that with ordinary materials the concretes such as are represented at the extreme right, Figure 7, are almost as strong (within about 10 per cent) as that represented at the extreme left, mortar. Researches by others show that the presence of the large aggregate may reduce the strength below that of the mortar by as much as 15 or 20 per cent. The discrepancies between the different reports, unimportant though they are from the practical standpoint, are the subject of a considerable amount of discussion. It is probable that differences in the characteristics of the large aggregates are responsible for some of the differences in test results. For example, in experiments made by the writer the large aggregate was extremely hard and unyielding, having a modulus of elasticity of between 10 and 20 million and the strength loss due to the large material was considerable. In the Denver tests, on the other hand, the large aggregate was said to have an elastic modulus much closer to that of the mortar in which it was embedded. This, as may be seen without detailed discussion, offers a possible

Figure 6
The Consistency and General Appearance of the Mass Concrete Placed in Boulder Dam.

[1] Effect of Cobbles on Concrete of Lean Proportions, Tech. News Bull. 100, Bureau of Standards, Aug., 1925.
Concrete Studies at Bull Run Dam, by T. C. Powers, Proc. A. C. I. 25, 383, 1929.
Study of Elastic Properties of Concrete, Tech. News Bull. 162, Bureau of Standards, Oct., 1930, p. 102.
Boulder Dam Cement and Concrete Studies, by R. F. Blanks, Eng. News-Rec. *113*, 648, 1934.
Mass Concrete Tests in Large Cylinders, by R. F. Blanks and C. C. McNamamar; Jl. A. C. I., *6*, 280, 1935. Discussion, Jl. A. C. I., 7, 234, 1935.
An Investigation of the Permeability of Mass Concrete with Particular Reference to Boulder Dam, by Arthur Ruettgers, E. N. Vidal and B. P. Wing; Jl. A. C. I., *6*, 382, 1935.

explanation for the 10 or 15 per cent differences under discussion.

Researches at Denver also supplied data as to the effect of the large aggregate on permeability to water under pressure. In this case the presence of the large aggregate was found to increase the permeability considerably, especially for concrete of relatively high water-cement ratio. This is contradictory to the cement paste theory as simply stated above; that is, that the penetrating water must pass through the spaces between the stone and that because these spaces are filled with cement paste, the degree of permeability is determined by the characteristics of the cement paste. Since the paste is the same in the concrete as in the mortar, there seems to be no reason to expect any important differences in permeability. Nevertheless, the test results must be accepted and an explanation of the cause for this apparent contradiction of theory sought. The answer is not hard to find. The fact is that the spaces between the aggregate particles are not completely filled with the paste or, more accurately, they are not uniformly filled. For concrete made according to customary practices there is always a period of settlement immediately following placing. This settlement is manifested by an accumulation at the surface of water which has been displaced from below by the settlement of the solids. This phenomena, observable at the surface also occurs throughout the interior of the mass, that is, the cement particles tend to settle in the water in which they are suspended, leaving little else but water in contact with the under side of the aggregate particles. After a very slight settlement the aggregate particles may become packed and no longer capable of following the settlement of the cement particles. Or the settling of the cement particles may occur faster than the water can find its tortuous way from beneath the larger particles. Thus there develop zones under all aggregate particles which offer a minimum of resistance to the flow water. Apparently, the larger the particle size the greater this zone of relatively low density. Thus it is perfectly logical from this viewpoint to expect an increase in permeability with increase in size of aggregate. However, it must be pointed out that the phenomenon of settlement and bleeding is evidence of an unbalanced mix and can, by proper design, be overcome. It should be easily possible to produce mass concrete more watertight than that which was tested in the Denver tests. It should not be inferred that the concrete employed in the Denver tests was seriously permeable. The amount of leakage involved even in the most permeable specimens would never be detected in service.

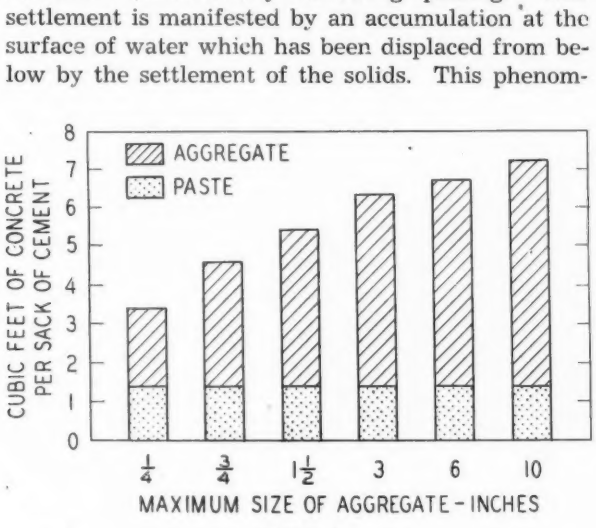


Figure 7

Quantities of Concrete Produced from one sack of Cement with Aggregates of Maximum Sizes Designated. Conditions:—Concrete of 6.5 gal. per sack, 3 to 5-in. slump, natural sand and gravel.

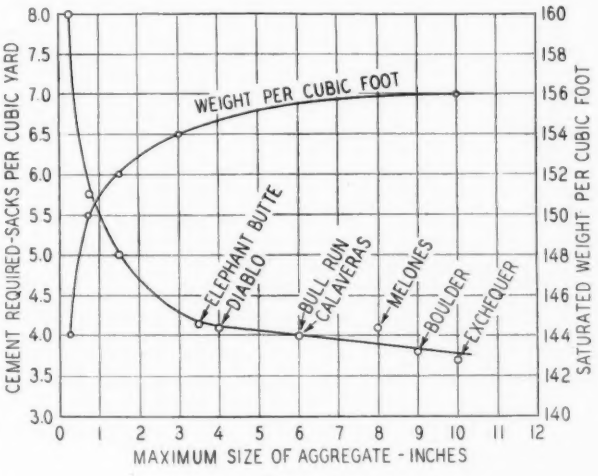


Figure 8

Influence of Size of Aggregate on the Cement Required to Produce 6.5 gal. per sack Concrete having a 3 to 5-in. slump.

Handling

The handling of mass concrete is not difficult provided that the equipment is designed for that type of aggregate. Although it has been proved possible to use a wide variety of gradations so as to accommodate the production of pit or quarry, it has also

been found to be highly desirable, if not absolutely necessary, to furnish the aggregate in separated sizes of rather narrow size limits. Only by so doing is it possible to produce a uniform concrete. It can readily be seen that the opportunity for segregation or "ravelling" in stock piles or bins increases to a serious degree when the size range is increased. But by proportioning from multiple bins, or several stock piles these difficulties are overcome. It is well worth while to make the small initial expenditure necessary to provide for handling several sizes, for experience has shown that a small investment here returns large dividends in increased production and a smooth-running job.

Summary

This discussion may be very briefly summarized as follows: For conditions where its use is feasible mass concrete, *i. e.*, concrete containing aggregate larger than about 2 inches, is highly desirable because it is heavier, gives less temperature rise and volume change, and usually is less costly. With proper precautions and equipment it is easily handled. By proper design of the mix it can be made to give, to any degree desired, necessary strength, watertightness, or resistance to weathering.

National Officers to Visit Southwest and Intermediate Points

LEAVING Washington on April 19, Engineering Director A. T. Goldbeck and Administrative Director J. R. Boyd will make an extensive trip through the Southeast, Southwest and Middle West, in the interests of more intimately acquainting crushed stone producers with the activities and accomplishments of the National Crushed Stone Association and also to give these officials opportunity of obtaining first-hand information with regard to specific problems affecting the crushed stone industry existing in the various territories to be visited. An additional feature of the trip will be to give Mr. Goldbeck opportunity of contacting various state and county highway officials on matters of mutual interest with specific regard to problems affecting the crushed stone industry.

The first stop will be Columbia, S. C., where a meeting of the producers in that area is being scheduled for April 20 under the supervision of Regional Vice-President T. I. Weston. College Station, Texas, will be the next stop, where Mr. Goldbeck will address the Twelfth Annual Highway Short Course given at the Texas A. and M. College, on April 24. The party will then proceed to Austin, Texas, where on April 25 officials of the Texas State Highway Department will be contacted and a visit made to the State Highway Testing Laboratory. Regional Vice-President E. Eikel for the Southwestern Region and W. F. Wise, former President of the Association, are handling the Texas arrangements. On April 27 a meeting will be held in Kansas City, Missouri, under the auspices of Carl Hise, Secretary-Treasurer, Missouri Aggregate Association. Meetings will then be held successively in St. Louis, Missouri, on April 28, with arrangements in charge of E. J. Krause and Ralph E. McLean; in Nashville, Tennessee, on April 29, and Louisville, Kentucky, on April 30, under the supervision of H. E. Rodes, President of the Association; in Columbus, Ohio, on May 1, with Russell Rarey, in charge of arrangements; and concluding with a visit to Pittsburgh, Pa., on May 4, final arrangements concerning which have not been completed as yet.

All crushed stone producers, whether or not members of the Association, are most cordially invited to be present at the meeting scheduled in their territory, detailed announcement concerning which will be mailed locally. It is entirely possible that our mailing list is not complete and consequently, even though a producer does not receive a personal invitation, he should feel most welcome and should not hesitate to take advantage of the opportunity of learning more in detail of the work of his national Association. Time will be available at each meeting place for producers to consult with Mr. Goldbeck concerning any technical problems concerning which specific information is desired.

This trip of the executive officers inaugurates a policy for the current year of maintaining contact with members in the field more frequently than has been possible in recent years. A number of additional trips are planned during the remainder of the year for the purpose of contacting other important producing centers of the industry.

Association Opposes Extension of Emergency Charges Authorized in Ex Parte 115

AS INDICATED in the last issue of *The Crushed Stone Journal,* the National Crushed Stone Association participated in the current proceedings before the Interstate Commerce Commission in connection with further hearings in Ex Parte 115, resulting from the application of the carriers for indefinite extension of the emergency charges previously authorized in these proceedings. Opposition by the Association to any further extension of the emergency charges was predicated on the results of a limited survey of a selected group of rail shippers, necessitated in view of time limitations, which confirmed our previous judgment that the application of the carriers should be opposed in view of the diversion of rail traffic to other forms of transportation resulting from the imposition of the emergency charges and because of the disturbing effect upon competitive relationships brought about through the percentage increase.

In accordance with the expressed desires of the Interstate Commerce Commission that those interested in the same commodity or subject should endeavor to coordinate their presentation and avoid duplication, the three mineral aggregates associations jointly participated in the presentation of testimony through V. P. Ahearn as witness. Following is the full text of the joint statement presented before the Commission:

"This presentation is made on behalf of producers and shippers of crushed stone, sands for all uses, gravel, and slag, in the entire United States. The organizations which I represent in this proceeding are voluntary associations of their industries, the specific functions of which are a matter of record in the original hearings.

"The Associations, individually and jointly, have appeared before your Commission on numerous occasions when increases were proposed by the carriers in the rates on the commodities produced by their industries. They have emphasized in such proceedings, and that sentiment is here reaffirmed, that they recognized the interdependence between a prosperous condition of the railroads and a healthy condition in industry in general, and they have an abiding interest in any undertaking which has as its objective the increasing of carrier revenues. Most of our plants were designed for railroad loading and an improvement in carrier revenues from the transportation of our materials necessarily means a greater degree of activity in our established plants; and there is the further consideration that the railroads, particularly in other years, are substantial users of our products.

"Notwithstanding our sympathetic interest in the need of the carriers for additional revenue, it is of no benefit to them or to ourselves to carry that sympathy to the point of refusal to recognize and face facts. Any proposal for an increase in freight rates which has as its objective the production of greater revenue for the carriers, embodies the assumption that higher rates will not disturb the normal flow of traffic. In the case of our industries, such an assumption is a fallacy, as the records of the Commission itself so eloquently prove.

"Attention is directed to a table which I have prepared and distributed and which I desire to introduce as an exhibit. It shows the relationship of rail tonnages to the annual production of sand and gravel and crushed stone for the years 1928 to 1934, inclusive. Unfortunately, no official information is available as to slag. This statement supplements our exhibits and data presented in the original hearing in Ex Parte No. 115, by adding thereto the results for the year 1934.

EXHIBIT

COMPARISONS OF PRODUCTION AND RAIL SHIPMENTS OF CRUSHED STONE AND SAND AND GRAVEL.[1]

Year	Annual Production, tons	Rail Shipments originated tons	Percentages of 1928		Rail Shipments, per cent of Production
			Production	Rail Shipments	
1928	252,858,825	121,133,616	100.0	100.0	47.9
1929	263,703,757	114,937,147	104.0	94.9	43.6
1930	250,185,050	105,810,641	98.9	87.4	42.3
1931	208,853,773	79,423,153	83.6	65.6	38.0
1932	162,387,863	44,113,009	63.8	36.4	27.2
1933	142,439,582	33,853,176	56.3	27.9	23.8
1934	167,395,618	43,359,430	66.2	35.8	25.9

[1] Production data from reports of U. S. Bureau of Mines. Rail shipments data from reports of Interstate Commerce Commission.

"In 1928, as the statement discloses, the railroads handled 47.9 per cent of the total production of the sand and gravel and crushed stone industries; in 1929 they handled 43.6 per cent; in 1930, 42.3 per cent; in 1931, 38.0 per cent; in 1932, 27.2 per cent; in 1933, 23.8 per cent; and in 1934, 25.9 per cent. The conclusion is inescapable that the freight rates imposed on our commodities by the railroads have been substantially in excess of what the traffic will bear, and have had the inevitable effect of diverting our traffic from the railroads to competing forms of transportation. Such a result reacts to the mutual disadvantage of

the railroads and ourselves. The intolerably high level of rates has exposed our established plants not only to wayside pit competition but to the additional hazard, all too realistic today, of governmental production of our materials in order to satisfy public works requirements.

"With the use of 1928 railroad tonnages and production totals as the basis of calculations, it will be observed from my exhibit that production in 1934 had declined to 66.2 per cent, but that rail tonnage was only 35.8 per cent of the 1928 figure. Production in 1934 was greater than in 1932 and 1933, but rail tonnages in 1934 were less than in 1932, although greater than in 1933. This mutually helpful increase in rail tonnage for the year 1934 as compared with the preceding year can be attributed in our judgment to the fact that in that period the railroads established many special rates to meet competition, thus preserving the traffic for the railroads. The greatest decline in rail tonnages as compared with total production occurred in 1932, when the full effect was felt of the increases authorized by the Commission in the Fifteen Per Cent Case, 178 I. C. C. 539.

"Complete information concerning the production of our industries during 1935 is not available, but from our knowledge of the sand and gravel industry and based upon reports submitted at its recent general meeting, we are warranted in making the statement that production for the year 1935 in that industry will exceed the total for the year 1934 by about 10 per cent. We have examined reports of the Commission concerning rail tonnages for the first nine months of 1935, and comparing our estimates of increased production during that period with the rail totals, we find that there has been a decline in the amount of sand and gravel and crushed stone handled by the railroads in the first nine months of 1935, thus arresting the upward trend registered in 1934, when rates were more nearly adjusted to a level which would permit our traffic to move.

"This decline in the amount of our business handled by the railroads has occurred in 1935 despite the fact that the carriers have continued to establish special rates in many cases in order to avoid the loss of rail movement. As an illustration, in one State alone more than two hundred cases of special reduced rates were reported in 1935. While the willingness of the carriers to lower their rates in individual cases below even the level prevailing prior to the imposition of the emergency charges authorized in Ex Parte No. 115, has mitigated the severity of our losses, the practice of publishing special rates is open to two criticisms. First, the reduced rates lack permanency, and uncertainty as to the reinstatement of the normal rate causes confusion and disorder; second, special reduced rates are generally applied only to large movements, and the normal level of rates is applied to the ordinary requirements for our materials at principal consuming points. This phase of our market, while individually small, amounts to an imposing sum in the aggregate. It has been amply demonstrated that each year the established plants are being forced to yield this market to shippers by truck. As a general proposition, it may be stated that revision of rates to meet special cases is extremely ponderous, and all too frequently relief comes when it is too late for the railroads and ourselves.

"In its decision in Ex Parte No. 115, the Commission authorized emergency charges of 7 per cent on freight rates on our materials where rates were in excess of $1 per ton, with a maximum increase of 20 cents per ton. No emergency charges were authorized on rates of $1 per ton or less. The only exception to this was that in connection with industrial sand in box cars and on naturally bonded molding sand in all types of equipment, the emergency charge was authorized on all rates with a permissible maximum of 40 cents per ton.

"In numerous proceedings before your Commission our industries have emphasized that percentage increases in rates have the unfortunate effect of changing and disturbing competitive relationships. In its decision in the Fifteen Per Cent Case, the Commission expressed the permitted increase in our rates in flat cents per ton, although the carriers had applied for a percentage increase. It seemed reasonable for us to assume that the Commission had been responsive to our request that a revenue case not be permitted to destroy competitive relationships then existing, which in many cases had been established as the result of formal proceedings before this Commission. In their application for increased rates under the original hearings in Ex Parte No. 115, the carriers sought to have our rates increased in flat cents per ton, but the decision of the Commission set aside the precedent established in the Fifteen Per Cent Case and expressed the authorized increase in terms of percentages. The immediate result sustained the objection which we voiced in the Fifteen Per Cent Case. Many members of our industries have been compelled to abandon normal and logical markets, rail hauls of our materials have been lowered with a consequent reduction in carrier revenues, and in many cases there has been a complete loss of the traffic by the railroads.

"When the carriers filed their application for indefinite extension of the emergency charges authorized in Ex Parte No. 115, the Associations joining in this statement consulted with their respective member companies in all parts of the United States. The replies to their inquiries have, without exception, stated that in the interest of increasing carrier revenues on our materials, the emergency charges should be permitted to expire. Furthermore, the objection has been consistently voiced that the percentage increase in our rates has caused a violent disruption of orderly competition. As an illustration, reference may be made to an important consuming market in Iowa, which one of our members in Illinois reached on a rate of $1.05 per ton prior to the effective date of the Commission's order. A competing plant shipped into this same market over another railroad for a rate of $1. The latter rate was not disturbed, but the former rate was increased 8 cents, resulting in a differential of 13 cents per ton which the Illinois producer was unable to overcome.

"Another pertinent illustration of the damaging effects of the percentage increase authorized by the Commission may be found in respect to those many markets where joint line and single line hauls are involved. For example, joint line rates subject to the West Penn scale for distances over 60 miles were assessed with the emergency charge because such rates exceeded $1 per ton. A producer with

(Continued on page 20)

Some Factors in the Development of a Mineral Wool Industry[1]

By CHARLES F. FRYLING[2] and ORVAL WHITE[3]

◆ New building construction is definitely increasing in volume; air-conditioning will be extensively used and insulation will be in demand. Rock wool, one of the best heat insulators for homes, offers a possible new market for certain types of stone and hence the present paper which treats of the technical and commercial phases of the rock wool industry should be of great interest to stone producers.

Properties and Uses of Mineral Wool

MINERAL wool is a light-weight material composed of thin, glassy fibers. The raw material from which it is produced consists either of sedimentary rocks, which appear to be mixtures of shale and limestone laid down simultaneously, or of various types of metallurgical slag. In order to secure a material which can be melted and blown into wool, it is necessary that its acidic and basic constituents be fairly evenly balanced.

Chemically, rock wool, which can be defined as mineral wool obtained from naturally occurring rocks, consists of silica, alumina, lime, and magnesia in combination. The composition limits have been determined experimentally.[4] One important point revealed by this study is that the properties of rock wool are definitely determined by composition and blowing conditions. Therefore, provided the composition is correct, it is immaterial whether the wool is produced from a single rock, a mixture of rocks, or from some other material such as slag. Slag wool and rock wool of the same chemical composition, and blown under the same conditions, would be indistinguishable. However, it must be remembered that many slag wools are produced having compositions which are quite different from those yielded by rocks, and the differences in the product may be quite marked.

The most important use for mineral wool is as a heat insulating material. The tangled mass of fibers of which the material is composed serves to entrap a large number of small air pockets which, in turn, impart the property of low heat conductivity to the aggregate. Mineral wool has many advantages compared with other heat insulating materials. Among these may be mentioned:

1. On the basis of its coefficient of heat transfer, mineral wool ranks among the best commonly available heat insulating materials.[5]
2. Deterioration is practically nil. It is quite usual to find it unimpaired after 25 years or more of service.
3. In contrast with certain organic materials, it is inert toward moisture, and consequently its insulating properties show less tendency to fluctuate with changing weather conditions.
4. It is thoroughly fire-proof and vermin-proof. This should be of importance from the standpoints of health and insurance rates.
5. It can be fabricated in forms convenient for use in the building industry. Some of these are: loose fill, rigid board, and quilts.
6. It is an excellent acoustical insulation material. In this connection, it is interesting to recall that it was used to insulate the broadcasting studios of Radio City.
7. It is relatively inexpensive, and the indications are that it can be produced more cheaply than it is at present.

Although finding considerable use in industry, there is much to indicate that mineral wool will find its widest use in the insulation of buildings. It can be expected to contribute towards better health by equalization of room temperatures, elimination of drafts, increased comfort in both summer and winter, and reduction of vermin and fire hazards. That it contributes materially towards the economical use

[1] Published with the permission of the Chief, Illinois State Geological Survey, Urbana, Illinois. Material presented at the Third Annual Mineral Industries Conference of Illinois; Urbana, May 18, 1935.
[2] Chemist, Non-Fuels Division, Illinois State Geological Survey.
[3] President, Mineral Insulation Company, Chicago Ridge, Illinois.
[4] Illinois State Geological Survey Bulletin No. 61, "Rock Wool from Illinois Mineral Resources," Urbana, Illinois, 1934.
[5] Loc. cit. pp. 237-39.

of fuels is well known. A recent publication[6] gives the calculated heat losses through 1,000 square feet of wall. The wall consisted of clapboard on sheathing with building paper between, 2 by 4 studs set at 16-inch intervals, and an inner wall of wire lathe and plaster. The calculation was made for a 15-mile per hour wind velocity, 200 days heating season, 30 degrees average temperature difference, and 24-hour load, with the following results:

	Heat Loss	Equivalent[7] Tons Coal
No insulation	38,000,000 B.t.u.	1.6
1 inch of rock wool	18,700,000 B.t.u.	0.8
3⅝ inch rock wool	8,600,000 B.t.u.	0.4

Manufacturing Process

The production of mineral wool from slag has been practiced for about 60 years. The most important improvements, however, were made about 35 years ago by C. C. Hall, who established a plant for the production of rock wool at Alexandria, Indiana. Incidentally, the rock wool industry was born during the depression of 1896. Mr. Hall, who had been operating a steel mill at Alexandria, tried local stone to find a more inexpensive fluxing agent. He found that the slag produced by the local stone readily blew into fibers when struck by the air blast of the smelter. He experimented further to satisfy his curiosity. After the steel mill had been closed, he investigated the possibility of using cheap natural gas, then available, to make fire-proof insulation out of the self-fluxing stone that he had discovered. He erected his first plant without further experimentation. The picture (Figure 1) shows Mr. Hall, the first plant, the first car-load of mineral wool shipped from Alexandria, and the first men employed in the rock wool industry.

Courtesy of Mr. C. C. Hall

Figure 1
First Rock Wool Plant

The first melting equipment is also visible. This was simply a brick puddling furnace employing natural gas fuel. It was constantly giving trouble, because of refractory corrosion. Under these inauspicious conditions, the rock wool industry started. To Mr. Hall, the industry owes a tribute for thirty years of hard work put forth in its behalf.

Present-day practice follows very closely that finally established by Mr. Hall. Cupolas, about 5 feet in diameter and 8 feet high, are used. (Figure 2.) A mixture of rock, or slag, and coke, is fed into the top of the cupola, and molten material flows out at the bottom in a steady stream. Combustion is supported by a blast of air fed into the bottom of a cupola which in some respects resembles the type of equipment used for melting cast iron. A temperature of about 1500 degrees Centigrade is attained, and cooling is effected by a water jacket. A steam blast, issuing from a trough-shaped nozzle at a pressure of about 100 pounds per square inch, is directed at approximately a right angle to the stream of flowing material. This is broken up into innumerable small droplets which are propelled into a collecting chamber. During its flight through the air, each little droplet drags out a small thread of material which solidifies before falling.

Cupola capacity is rated at 1000 pounds of wool per hour, but 500 pounds per hour has been considered satisfactory. The raw material must not be so fine that it blows out of the cupola or plugs it up. It is considered advisable to use an assortment of definitely sized materials in order to prevent excessive channeling within the cupola. The object of the melting operation is to secure a steady stream of molten material of homogeneous chemical composition at the proper blowing temperature.

The wool may be collected on an endless belt in a chamber about six feet wide and forty feet long. A small amount of oil is usually added to the steam used for blowing in order to reduce dust, to secure better cohesion, and to produce a more water-resistant product.

The crude wool can be fabricated into the various forms required by trade. It can be treated in special equipment in order to produce a refined product for blowing between walls; it can be loosely compressed into blankets, inserted into ready-built forms, sewed

[6] Sheet Metal Worker 26: 41-2, Ja. '35.
[7] The coal equivalence was calculated by us on the basis of 12,000 B.t.u. per lb. of coal.

up between paper or wire netting to form quilts, or fabricated into plasters, bricks, and other forms. One difficulty encountered in fabricating mineral wool is slow drying, a consequence of its low heat conductivity. For this reason, it is essential to keep the wool fairly dry during the blowing process.

Improvements Possible in Rock Wool Production

(a) With present type of equipment:

It seems probable that most mineral wool plants now in operation are antiquated. Chief difficulties encountered are high and variable fuel consumption, wide variation in quality of product, and inability to maintain continuous operation.

These difficulties can be largely attributed to the empirical nature of the present manufacturing procedure. Little effort to establish control of the raw materials has been attempted. Rocks which are assumed to be of the proper composition are used, and temperature is controlled according to the whim of the operator. It is therefore necessary to provide some degree of chemical control. Methods analogous to those used in the cement industry would be ideal, but the possibility of introducing such complete control at the present time appears to be too great an advance to bring about immediately. It is therefore suggested that a carbon dioxide determination might be used to advantage. The weight of carbon dioxide in naturally occurring rocks is a fairly accurate measure of the basicity of the melt. The data would be used to proportion the charge so that its average carbon dioxide content would be some specified value, say, 28 per cent. It is evident that this method can only be applied as a control in the production of rock wool, and is not applicable in the case of slag wool.

It is possible to suggest certain ways in which the efficiency of the present type of equipment might be improved; but before these are undertaken, an accurate heat balance for the process should be secured. Apparently, the cupolas have not been designed with an eye to heat economy, for the rock can be melted much faster than it can be blown. It would not seem impossible, however, to blow two or three streams simultaneously from the same cupola. At the same time, the possibility of reclaiming waste heat from the cupola and stack should not be overlooked. The U. G. I. producer gas generator, according to Haslam and Russell,[8] utilizes the water cooler for the generation of steam. The possibility of effecting a similar economy should be investigated by a competent engineer.

A means of following the temperature of the slag stream should be provided. Adequate equipment should be provided to eliminate operating hazards.

(b) Possible improvements in the process:

It is quite evident that present methods are rather limited as regards the range of compositions which can be employed, the type and size of raw material,

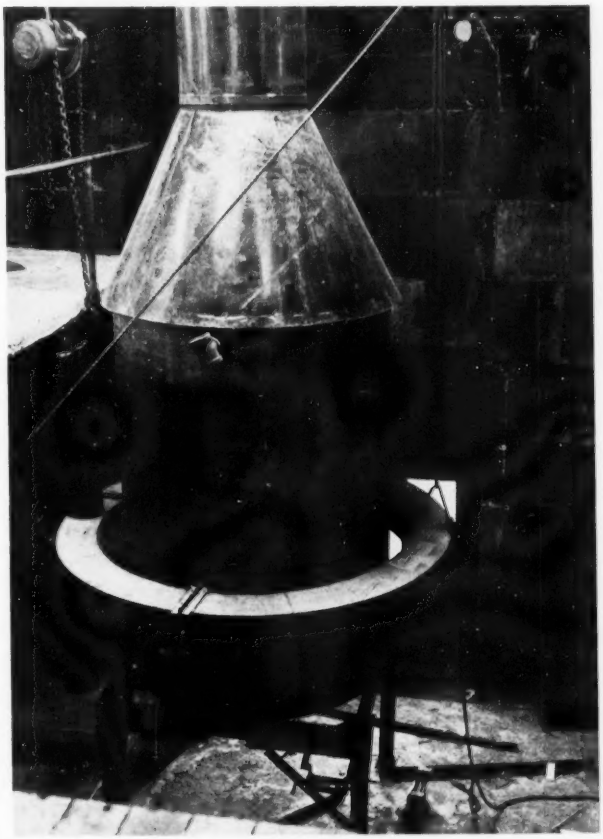


Figure 2
Mineral Wool Cupola Under Construction

and the extent to which mixtures of raw materials can be accommodated. A method allowing the use of mixtures, say of limestone and shale, would enjoy the following advantages:

(1) It would be possible to produce a product of predetermined composition.

[8] Haslam and Russell, "Fuels and Their Combustion," McGraw-Hill Book Company, 1926, p. 587.

(2) The location of the plant would be independent of the occurrence of woolrocks and could be decided entirely on economic considerations.

Some industrial attempts have been made to produce mineral wool by admixture of silica sandstone and limestone.[9] The literature does not indicate what success has attended these efforts.

We wish to suggest pre-sintering of pulverized raw materials in a rotary kiln as a suitable method for production of clinker of controlled composition for subsequent melting in a cupola. Mineral wool could then be made from suitable mixtures of the following materials: homogeneous or non-homogeneous woolrocks, sandstone, shale, sub-woolrocks, slag, cinders, cement rock, clay, sand, gravel, loess, till, limestone, dolomite, oyster shells, etc.

On the basis of data presented before Congressional hearings on the tariff (Schedule 15, 1929) regarding the cost of portland cement production one of us has estimated that the cost of grinding, mixing, and pre-sintering should be from $1.50 to $2.50 per ton of clinkered material. This added cost should be off-set, in part or in toto, by the following economies in cupola operation:

(1) Reduction of fluctuations in output of the cupolas.
(2) Reduction in fuel consumption for the cupola operation.
(3) The cheapest raw material available at any given time, from the list just presented, could be used.
(4) "Mineral wool cullet" could be used over by putting it through the sintering process. It would constitute the very cheapest form of raw material possible.[10]

These possibilities for improvement in the production of rock wool indicate that the cost of production can be materially decreased.

Finally, unless one has had actual operating experience and is thoroughly familiar with the process, it would be rash to build a full sized plant. In the development of any industry from research, several steps are desirable before the process can begin profitably to produce for the market. A small scale plant should be built and operated successfully in order to obtain the engineering data necessary for the design of the full scale plant. The nucleus of a sales force must evaluate the product of the plant and determine in what manner it can best be marketed.

[9] Thoenen, J. R.—"Mineral Wool." Information Circular No. 6142, U. S. Dept. of Commerce, Bur. of Mines, June, 1929.
[10] In the production of granulated wool, and other finished products, there is a large loss due to sifting out of shot, large fibers, and other coarse material. At present, this loss may amount to 50 per cent by weight of the wool produced.

Economic Factors

At the present time, there are approximately thirty producers of mineral wool. This includes the producers of both slag wool and rock wool, as well as at least one firm which produces a mineral wool using soda-lime glass as the raw material. It is apparent that the number of producers is increasing. There are three or four plants operating in the vicinity of Los Angeles, eight in Indiana, and plants are either in operation or are being established in Texas, Ohio, New Jersey, Vermont, and Illinois.

For many years the industry was largely centered around Alexandria, Indiana, but the general trend at present seems to be toward decentralization in order to supply local needs more economically. The factors which favor this decentralization, as well as those which are temporarily hindering it, are significant.

The large volume occupied by a ton of mineral wool limits the amount of material that can be loaded into a box car. The bulk density of the material is about ten pounds per cubic foot, and only approximately 12 tons can be loaded per car. Therefore, the freight rate is high. The freight rate on rock wool from Alexandria to various points is as follows:

FREIGHT RATES PER TON ON ROCK WOOL FROM ALEXANDRIA, INDIANA

Chicago	$4.80	Kansas City	$10.40
Cleveland	5.80	Minneapolis	11.20
St. Louis	6.00	Birmingham	15.00
Baltimore	9.00	New Orleans	19.40
Philadelphia	9.40	San Francisco	52.80
New York	10.00		

Another factor favoring decentralization of the industry has been the discovery of woolrocks in various places. Within the past four years, the discovery of woolrocks has been recorded in geological reports from Ontario, southern Indiana, and Illinois. Developments are now under way which indicate that premixture of limestone and shale is feasible. If successful, this will make the industry independent of the location of woolrock deposits and will accelerate the decentralization process.

There are several factors, however, which have retarded rapid decentralization of the rock wool in-

dustry. Among these has been the Rock and Slag Wool Code. Under the code, a uniform retail price of about $50 per ton has been maintained throughout the United States for mineral wool in bulk, and the price of the material refined for blowing into houses has been approximately $70. This uniform price made it difficult to start up in a new locality and secure the bulk of the market by cutting prices by an amount equal to the freight differential.

The patent situation is also a factor in delaying complete decentralization. Six of the larger producers are reported to control the patents for blowing refined rock wool into the walls of dwellings which have already been built. This makes it difficult for newcomers to break into what may be the most lucrative phase of the house insulation business. However, it is possible that these patents will be broken when their validity is tested in court.

Increased use of automobile trucking has helped the industry to overcome, to some extent, the unfavorable freight rates, thus delaying the necessity of decentralization. Since only one handling is involved, paper bags in place of burlap bags can be used. This difference in cost amounts to about $6.00 per ton.

The tardy recognition of the value of insulation in homes has been a serious drawback to the industry. It has taken the public some years to discover the merits of the various types of insulation available. Mineral wool has no structural properties; it is used solely for its heat retarding qualities. At the present time, mineral wool for house insulation meets practically no sales resistance, and it is possible to look forward with confidence to a widespread increase in its use.

Other important considerations for the prospective producer of mineral wool are the following: probable market; plant cost; production cost; and fuel cost. In the discussion of these, it should be realized that accurate figures can be obtained only from complete cost data. Furthermore, it must be remembered that such figures will vary from plant to plant, and from time to time. Nevertheless, with these limitations, we think that the estimates which we are able to present will be of value.

Probable Market

In 1931, the American Builder and Building Age published a series of articles attempting to evaluate the future market for insulating materials. The material for these articles was collected from the building industries by the publication. On the basis of the number of buildings which could be profitably modernized, and the probable new construction, it was estimated that there was an annual market for 11,700,000,000 square feet of insulating materials. At the time, it was thought by one of us that mineral wool could capture at least 50 per cent of this market, and it was estimated that the probable future market for mineral wool could be placed at $100,000,000.

Now that the economic trend seems to be upward, it is interesting to re-examine these figures. Apparently mineral wool has captured at least half, if not more, of the building insulation business. Subsequent to 1933, the mineral wool business has witnessed renewed activity, and has expanded beyond its pre-depression high. Three million dollars is believed to be a conservative estimate of the present annual business; and, considering the delayed housing construction, it does not seem unwarranted to expect the $100,000,000 per annum figure to be attained within a few years.

Cost of Plant

The following estimate is based on the use of new materials. The capacity of the plant is rated at 1000 pounds of mineral wool per hour. Again, it should be remembered that local conditions may affect the cost one way or the other from the figures presented.

ESTIMATE OF COST OF A TWO-CUPOLA ROCK WOOL PLANT

Cupolas (2)	$1,500
Blowers	1,400
Steam boiler, pipes, valves, and stack	3,000
Collecting belts (2)	1,600
Shredding machinery	500
Dryer, wool compressor, etc.	5,000
Building materials	10,000
Labor	8,000
Power and water	1,000
Miscellaneous	6,000
TOTAL	$38,000

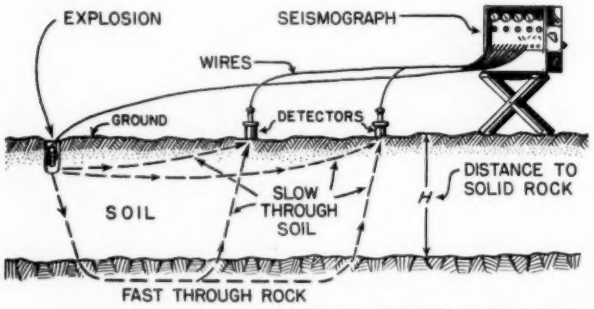
An operating plant, with quarry and land, should therefore cost from $50,000 to $75,000. This makes no allowance for pilot-plant development, or the development of an adequate sales organization.

Fuel and Production Costs

The cost of fuel will vary with the location. It is reported that coke is obtainable in the Chicago area at from $4 to $5 per ton. Approximately one ton of coke is required per ton of wool produced. With the present type of equipment, it should be possible to produce wool at a figure under $20.00 per ton, figuring all costs.

Simple Method Measures Depth to Rock

BY PRECISE timing of sound waves racing through earth and through earth and rock, engineers of the Bureau of Public Roads have developed practical field methods for determining the distance below the ground surface to solid rock. These engineers have perfected an instrument by which measurements can now be made on the surface with apparatus that will indicate within a few feet how far below the surface rock will be found. Engineers need such information in planning bridges, buildings, estimating the cost of grading for highways and for other purposes. The measuring instrument is a highly sensitive electrical device known as a seismograph. The method saves the time and expense of drilling to find out how deep the rock lies.



Bureau of Public Roads, U.S.D.A.

Simplified Apparatus for Measuring Depth to Rock

Accurate results are obtained by measuring the speed with which an impulse from the explosion of a buried blasting cap or small charge of dynamite travels through the ground. Such an impulse will travel through soil at a speed of 1,000 to 6,000 feet per second but the speed through rock is 16,000 to 20,000 feet per second. A cap is exploded in the ground and at the same time the electric current exploding the cap causes a record to be made with precise apparatus for measuring time. Special detectors are placed at different distances from the explosion and pick up the impulse as it comes through the ground. The detectors are electrically connected with the time-recording device and the time of travel of the impulse from the explosion can be measured to a small fraction of a second.

When a detector is close to the explosion one impulse coming through the soil is received. At a greater distance an impulse coming through soil is received and a second one moving down through soil to rock, through rock, and from the rock up to the surface arrives a fraction of a second later. At still greater distances the impulse moving through soil and rock arrives ahead of the impulse moving more slowly through soil alone. Knowing the speed of travel through soil and through rock and the time of travel through different distances it is possible to calculate how far the impulse went downward through soil before it encountered rock.

This method has been used extensively in prospecting at considerable depth for oil. Elaborate and costly apparatus has been used. The Bureau of Public Roads has now developed simplified apparatus that is giving excellent results.

Mineral Aggregates Institute is Dissolved

THE Mineral Aggregates Institute, by unanimous action of its Board of Governors, was dissolved at the meeting of the Board held in Washington on March 13, 1936. The decision to discontinue the Institute was reached in complete harmony and only after the most thoughtful consideration. As indicated in the following resolution, the authority vested by each Association in its two representatives on the Board of Governors differed in spirit and intent to such a degree as seemed to prevent making the Institute a real and valid agency for the promotion of the common welfare of the three industries.

"WHEREAS, It is apparent that whenever an emergent circumstance arises of common interest and concern to the three mineral aggregates associations, it is susceptible of effective treatment through the medium of such conferences as may be arranged by the duly established officers and staffs of the three associations; and

"WHEREAS, It appears that the authority vested by each Association in its two representatives on the Board of Governors of the Mineral Aggregates Institute differs in spirit and intent to such degree as prevents the Board of Governors from making the Institute a real and valid agency for the promotion of the common welfare of the three industries concerned; now, therefore be it

"RESOLVED, That the Board of Governors herewith terminates and dissolves the Mineral Aggregates Institute, and that each member of the Board herewith tenders his resignation."

Association Records Its Opposition to Healey Government Contracts Bill

IT WILL be recalled that during the last session of Congress the Walsh Government Contracts Bill was passed by the Senate and referred to the House of Representatives for action during the present session. Detailed information concerning the various features of this legislation, and its probable effect upon the crushed stone industry, was given to member companies through the medium of our legislative news letters issued during last year. The National Crushed Stone Association has expressed its opposition to the form of legislation represented by the Walsh Bill through the report of the Committee on Resolutions of the Mineral Aggregates Institute adopted at the time of the annual convention held in St. Louis last January.

On March 2, 1936, Mr. Healey of Massachusetts introduced a bill in the House of Representatives (H. R. 11554) as a substitute for the Walsh Bill. The Healey Bill is now pending before the subcommittee of the Committee on the Judiciary of the House, of which Mr. Healey is chairman. Far from removing the criticisms of our industry to the Walsh Bill, the Healey Bill is equally, if not in some respects, more objectionable. The Bill is applicable to direct sellers and contractors as well as to all sub-contractors and suppliers. Within its scope would be included contracts for construction articles, materials, supplies, equipment or services, except professional services, where the amount involved exceeds $2,000. Where applicable, it provides that the principal contractor shall agree as to classes of employment, described specifically or by reference in the invitation to bid, that he will pay employees not less than such minimum rates of pay and employ them not to exceed such maximum hours as the Secretary of Labor shall determine.

Discretion is given the Secretary of Labor to permit over-time employment, but a rate must be set therefor "not less than one and one-half times the basic hourly rate received by the employee affected." Conditions applicable to the principal contractor are considered as included in any transaction between the principal contractor and the sub-contractors or suppliers.

Extraordinary powers of investigation are conferred upon the Secretary of Labor as well as the authority to make such exceptions as to rates of pay and hours of employment as shall seem to be warranted. Standards for guidance in administering the proposed legislation in this regard are vague and indefinite. Under the terms of the Healey Bill there is certainly conferred upon the Secretary of Labor a dangerous and unwise power. It is understood that the Secretary of Labor recognizes this fact and will propose that a commission or board be established to administer the measure. The Bill, if amended in this regard, would be changed only as to detail and would continue to be objectionable as to fundamentals.

In accord with the viewpoint of the Association concerning this type of legislation formally expressed at the time of the St. Louis Convention, the Administrative Director, in behalf of the Association, submitted to the subcommittee of the Committee on the Judiciary of the House a statement setting forth our opposition to the Healey Bill, full text of which is given below.

Current opinion seems to indicate that this legislation has about equal chance of passage. It can only be defeated through vigorous action by industry. We consider it highly important that each member write the Representative from his area in the House of Representatives and also his Senators supporting the official position of the Association and urging that the Bill be defeated. Copies of such letters should be sent to the Washington office of the Association.

H. R. 11554

Hearings before Subcommittee of the Committee on the Judiciary, House of Representatives

Statement of J. R. Boyd

Administrative Director of the National Crushed Stone Association

Mr. Chairman and Gentlemen: The National Crushed Stone Association is a voluntary organization of crushed stone producers with members located in all parts of the United States. It is opposed to the passage of H. R. 11554 for reasons which are briefly outlined in the following.

The market of the crushed stone industry is largely affected by Public Works expenditures of the Federal Government either directly or indirectly. Consequently the Healey Bill (H. R. 11554) is of serious import to this industry and if enacted into statute would have a deterring in-

fluence upon such mild recovery as has to some extent occurred in this industry, especially during the latter part of last year. As to such modest recovery as has occurred in this industry, the Department of Labor statistics seem to indicate that employment in September, 1935, increased about 1 per cent over employment in May, 1935, and the same comparison as to months indicates an increase in payroll of almost 8 per cent. Wage and hour provisions of codes were drafted more than two years ago and there is no valid reason for the assumption that such schedules are now relevant yardsticks for the measurement of hour and wage requirements in the light of present economic conditions.

While the Healey Bill does not require adoption of code hour and wage standards, it is not improbable to assume that the Secretary of Labor would consider such code provisions as definitely relevant. There is, further, the danger that even higher wages and shorter hours may be adopted for specific contracts than are reflected in the former code for this industry. The unknown factor of individual discretion in this regard would introduce intolerable confusion and uncertainty into the orderly processes of our industry. Manifestly in such an industry as our own, it is definitely unfeasible if not impossible to segregate employees as to payroll, consequently in bidding upon such a specific contract it would be necessary to apply to all employees those wage and hour requirements as were specified under the authority of the Act. Such a condition would leave those producers bidding upon contracts affected in whole or in part by Federal funds, exposed to the competition in other classes of work of those not involved in such contracts and who might therefore be operating on a basis substantially lower as to labor cost. In our judgment this Bill is an attempt to effect by indirection that which the Supreme Court has held may not be done by direct methods. It suggests coercion by the Federal Government through its power of expenditure to accomplish that which has been denied it by direct legislation.

In seasonable industries such as our own, it is not to the best interests of our employees to establish an arbitrary maximum working week such as was provided for in the code and which might be reestablished through this Bill as regards all contracts affected by Federal expenditures. It appears to us that such legislation would tend to retard rather than stimulate employment and in that regard would be as objectionable to our employees as to the employers. It is our belief that Federal control of hours of labor and wages in whatever form tends to lead to the progressive shortening of the working week with a corresponding endeavor to maintain the weekly income of the wage earner. Such procedure would apparently increase wage rates but not actual earnings. It is probable that the accompanying endeavor to prevent a reduction in real wages would in the long run be impossible of attainment. The difficulty of meeting the varying conditions between different units of our industry would be most appalling. Our industry is definitely opposed, and has so recorded itself, in convention assembled last January in St. Louis, to any Federal legislation effecting industrial control even though we are prepared to support legislation concerning itself with reasonable regulation.

In our judgment this Bill represents control legislation and not mere regulation. It would be costly to administer; inequities would necessarily arise; small business units would find it increasingly difficult to stand the increased costs involved; a disruptive line of demarcation would be drawn between supplying contracts involving Federal expenditures as contrasted to those of another nature, thus penalizing those units endeavoring to supply Government agency contracts and yet meet in other fields competitors not so engaged; and in general would have a seriously disturbing effect upon our industry and would retard that reasonable recovery which is expected as to increased market demands as well as increase in labor employed and rates of pay by imposing upon this natural economic development an arbitrary control measure unrelated even with the best administration to natural conditions.

We respectfully but urgently request that this bill be not enacted into statute.

Silicosis and Similar Dust Diseases to be Subject of National Conference

UNDOUBTEDLY precipitated by the various probes and inquiries of alleged death in silicosis cases, resulting from the exposure to silica dust of the workers employed at the Gauley Bridge, West Virginia, Tunnel, this subject is now receiving important consideration by the Secretary of Labor. Upon invitation of the Secretary, a limited number of organizations specifically interested in the problem, were invited to attend a preliminary conference on silicosis and similar dust diseases held in Washington on February 26, 1936. The National Crushed Stone Association, through its Administrative Director, participated in this conference which included representatives of management, labor, various governmental departments and bureaus, insurance organizations, and groups devoted to the development of standards.

The following comments of the Secretary of Labor in opening the conference should be of especial interest:

"I want to tell you why we asked you to come to this conference; what we have in mind, and what we hope to be able to do. Alone, no Department of Government can deal effectively with silicosis or any other occupational disease. While a great deal is known about silicosis, lead poisoning, chrome poisoning and other occupational diseases, and while the Government issues bulletins and instructions, and spreads the news as far as possible, the

actual means of preventing these diseases lies in the hands of the people who are in contact with the hazards. That is why I am delighted that this conference is so well represented—this is the most powerful and influential gathering that has ever been held on this subject.

"The bringing together of minds of those who have had experience with this problem is the only practical way for Americans to work out its details. There are many persons in control of great industries who, in the past, have taken very effective means for the prevention of accidents and control of industrial diseases. Control of health hazards has been very largely a matter of mechanical arrangements, mechanical engineering, and study of ventilation systems, and the application of this knowledge to the particular operation at the point of origin of the hazardous dust, gas, or fume. The power and influence of employer groups that are aware of these hazards is of great importance.

"The wealth of information already in possession of Federal and State agencies and private industries ought to be pooled and a committee should be formed consisting of those who have a direct and responsible relationship to the problem. It ought to be reviewed by those who are working in the hazards, so that the means taken for the prevention of the hazard can be scientific, practical, and acceptable to the worker. By this I mean that in addition to being both scientific and practical, any means of controlling the hazard should permit the employee to work at a reasonable rate and under comfortable conditions while using such devices. The Department of Labor has invited you here to pool your knowledge and help us work out plans which can be recommended generally for the prevention of silicosis. You will be aware, of course, that where these hazards have been recognized, the States in various parts of the country are enacting legislation or have bills pending in their legislatures, all quite different, for the prevention of silicosis or for adding silicosis to the workmen's compensation law. Many of these measures are inadequate and are not uniform. We are being consulted constantly about these bills, and it is our desire when we give advice to States, to be in a position to furnish them information and advice which is based not only upon the research work of Government, but upon the research work of all industry as well. We want to be able to recommend the most satisfactory and practical approach to the method of handling this problem under the compensation law.

"It is infinitely better to have compensation for silicosis and all other occupational diseases under the regular compensation law than it is to provide, as has been done recently in some instances, for compensation for silicosis victims solely on the basis of damage suits. With silicosis covered by the regular compensation law, subject to regular control, the incentive for prevention is emphasized. Workmen's compensation laws have been one of the greatest incentives for the prevention of accidents and this will hold true for occupational diseases as they are added to the list.

"There are two sides to this question of coverage by the workmen's compensation laws; special coverage and general coverage. These two matters are debatable. However, with regard to prevention there can be very little debate except as to method. The method in one industry may not be practical in another industry due to varying hazards and exposures. We have practically overcome the hazard of silicosis in some industries where formerly it was common.

"We are anxious that the conference which we hope will grow out of this preliminary meeting shall be based on a practical approach to this subject. An organized presentation of our joint conclusions to any legislature should be sufficient to bring into law programs which are agreed upon as necessary.

"I want to ask those who are participating in this conference to believe quite sincerely that we are looking for a practical answer to the problem of how to prevent silicosis by a great variety of devices in the great variety of industries and processes in which this disease might occur."

A second conference was held in Washington on March 11, at which time plans were made for the holding of a national conference to be held later in the year. As soon as the plans for the national conference have matured, full information will be made available.

Mineral Industries to Hold Conference April 24 and 25

THE Fourth Annual Mineral Industries Conference, sponsored by the Illinois State Geological Survey, the Engineering Experiment Station of the University of Illinois, and the Illinois Mineral Industries Committee, will be held at Urbana, Illinois, Friday and Saturday, April 24 and 25, 1936. The theme of the conference will be, "Research", and its scope will cover the purposes and results of researches already in progress and what additional researches should be pursued to meet the present changing conditions in the mineral industries.

All members of the crushed stone industry are most cordially invited to be present at the conference.

Desirable Characteristics of Ballast

WRITING in the March issue of "Railway Engineering and Maintenance", P. T. Robinson, Engineer Maintenance of Way and Structures, Southern Pacific Railroad, San Francisco, California, makes the following interesting observations

concerning the functions and characteristics of railroad ballast:

"Primarily, the purposes of ballast are to distribute the load over the subgrade, to provide effective drainage under and around the ties, and to permit the track to be surfaced and lined without disturbing the roadbed. To perform these functions, the ballast should be sufficiently hard and tough to resist serious abrasion and pulverizing when tamped. It should possess moderately sharp edges to permit the locking of the individual pieces when it is tamped. It should also have sufficient weight to give it stability, and be free from minerals which might tend to cement it. The best ballast is obtained from ledge or quarry rock crushed to sizes ranging from ¾ in. to 2 in., the smaller sizes tending to fill the voids in the larger sizes so that graded ballast permits more solid tamping. Precious-metal slag also makes high-grade ballast which does not deteriorate readily.

"The proper depth of ballast under the ties is a matter of opinion, based on experience and supported by tests. Subgrade conditions have an important bearing on the matter. Subgrades which contain materials subject to deformation, such as clay, loam, etc., should be subjected to uniform pressure under moving traffic loads, for which reason the depth of the ballast should be not less than the tie spacing. If the subgrade is of more stable material which resists deformation, the minimum depth of the ballast should be 12 in. On branch lines over which light power is operated, if the subgrade conditions are normal, from 6 to 8 in. of ballast should suffice. Where rehabilitation work is under way, the old ballast should be leveled to the bottom of the ties to form a sub-ballast, with the new material placed above it to form the top ballast."

Federal Aid Legislation Introduced

BILLS providing for the continuance of Federal-aid for highways during the fiscal years ending June 30, 1938 and June 30, 1939, were simultaneously introduced on March 9 by Senator Hayden in the Senate and by Congressman Cartwright in the House. This proposed legislation is identified as House Bill No. H. R. 11687 and Senate Bill No. S. 4213. The legislation provides $125,000,000 per annum for regular Federal-aid, together with other highway authorizations, and if enacted would provide for a continuous highway program until June 30, 1939. Committee hearings have been completed in both the House and Senate and it is expected that the bills will be reported in both houses in the immediate future.

Association Opposes Extension of Emergency Charges Authorized in Ex Parte 115

(Continued from page 10)

single line facilities can ship materials a distance of 100 miles at a rate of $1 per ton, which is not subject to the emergency charge. Thus the joint haul shipper with a haul of 61 miles and a rate of $1.10 per ton, heretofore on a competitive basis in a given market with a plant having a single line haul of 100 miles and a rate of $1 per ton, is now deprived of the opportunity to compete because he is unable to overcome a differential established in a revenue proceeding by means of a percentage increase.

"The products of our industries, due to their widespread availability, have a relatively short average haul. In many instances, the delivered price of these materials reflects more of transportation cost than it does the price at the plant. Under these circumstances, our industries are highly sensitive to even the slightest increase in rates, and the delicate balance which controls our traffic over the railroads is such that even a modest advance in rates may provoke a drastic dislocation of our industries and a heavy loss in railroad revenues from our materials. Our contentions with reference to the revenue effect of increased rates have not been contradicted by the carriers, and nowhere in the decision of the Commission in Ex Parte No. 115 is the validity of our position denied. There the Commission found that the increases proposed by the carriers would increase revenues only temporarily if at all; that such increases would result in undue prejudice and preference as between different classes of traffic and as between different communities and shippers; that in many instances the proposals would result in distortion of relations prescribed by the Commission for which distortion no sound justification had been presented; and that the ultimate effect of establishing the proposed rates would probably be to harm rather than to help the railroads through diversion of traffic to other forms of transportation. This penetrating analysis not only applied to the application of the carriers, but it may be said with equal force of the emergency charges which the Commission permitted to be imposed on our materials. Indeed, by the use of percentages, the burdens imposed upon our industries were aggravated.

"We have endeavored in this presentation to point to a fact which is striking by its very simplicity: namely, that higher rates on our materials will cause, and have caused, a loss in revenue to the carriers. Our industries are vitally concerned in the proposal of the carriers for an indefinite extension of the emergency charges. We have arrived at a critical stage in the development of our industries, and we are profoundly convinced that the continued imposition of these emergency charges on an already overburdened rate structure will compel our industries to sacrifice investments totalling millions of dollars and deprive the railroads, at the same time, of business which in other years, as the records of the Commission will show, was one of the most important sources of freight revenue.

"We ask that the application of the carriers be denied and that the emergency rates be permitted to terminate."

MANUFACTURERS' DIVISION

of the

NATIONAL CRUSHED STONE ASSOCIATION

These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

Allis-Chalmers Mfg. Co.
Milwaukee, Wis.

American Cyanamid & Chemical Corp.
30 Rockefeller Plaza, New York City

American Manganese Steel Co.
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American Sealdrok, Inc.
135 S. LaSalle St., Chicago, Ill.

Atlas Powder Co.
Wilmington, Del.

The Barber Asphalt Co.
1600 Arch Street, Philadelphia, Pa.

The Barrett Co.
40 Rector Street, New York City

Bucyrus-Erie Co.
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C. G. Buchanan Co.
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Milwaukee, Wis.

Cross Engineering Co.
Carbondale, Pa.

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Simplicity Eng. Co.
Durand, Mich.

Taylor-Wharton Iron & Steel Co.
High Bridge, N. J.

The Texas Co.
135 E. 42nd St., New York City

The Thew Shovel Co.
Lorain, Ohio

The Traylor Eng. & Mfg. Co.
Allentown, Pa.

Troco Lubricating Co.
2728 N. Salmon St., Philadelphia, Pa.

Trojan Powder Co.
Allentown, Pa.

The W. S. Tyler Co.
3615 Superior Ave., N. E., Cleveland, Ohio